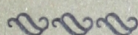
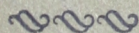


OZONE IN VENTILATION



**Heating Plant Economy
by Recirculation**



THE *Electroaire* CORPORATION
SUCCESSORS TO

Ozone Pure Airifier Co.

1455-57 W. Congress Street

Chicago



OZONE

IN

VENTILATION

*Heating Plant Economy
by Recirculation*

OZONE PURE AIRIFIER Co.
1455-57 W. CONGRESS STREET
CHICAGO



OZONE PURE AIRIFIERS
IN THE
CAPITOL BUILDING
WASHINGTON, D. C.

Q Two Ozone Pure Airifier Co., 100 unit generators are successfully operating in this building in connection with the mechanical ventilating system, reconditioning 100,000 cu. feet of air per minute. These are installed in both the Senate and House of Representatives, giving our legislators an adequate supply of fresh, invigorating atmosphere in which to conduct the affairs of the nation. - -

FOREWORD

*Prospective Builders
Building Owners
Architects
Engineers*

THIS booklet is issued for the benefit of Prospective Builders, Building Owners, Architects and Engineers. Its purpose is to outline, frankly and truthfully, the advantages offered by Ozone Ventilation and to describe the construction of the Ozone Pure Airifier equipment designed for this system.

The booklet explains:

First:—The system of Ozone Ventilation, and the advantages of this method of heating and ventilating over the old.

Second:—The construction of Ozone generating equipment. In this section each part of the generator is analyzed and the reasons for its construction given.

Our sales and engineering departments are at the service of our clients. Our sales organization, with representation in all the principal cities of the country is able to give personal advice on questions of Ozone Ventilation and our engineering department at the factory will cheerfully answer any questions relative to Ozone or any of its applications.

Every claim presented in this booklet is based on actual facts and should proof of any statement or further explanation of any point be desired we shall be glad to furnish it promptly on request.

OZONE PURE AIRIFIER COMPANY

72. + 10801-58 01

OZONE PURE AIRIFIER COMPANY, CHICAGO

OZONE VENTILATION SUPPLIES GOOD AIR

Recirculation in a ventilating system is not new. It has been attempted, but with indifferent success at various times during the past twenty years. Owing to the fact that in recirculation, the air has a tendency to become stale, to accumulate odors and to increase in bacterial count, recirculation was an admitted failure until some means could be found to correct these conditions.

The addition of the proper amount of OZONE revives the oxygen content, freshens the air and eliminates odors, thus proving Ozone to be the successful solution of the problem.

On first thought, it might appear doubtful to the layman, inexperienced in air conditioning problems, that recirculation of air plus Ozone (Ozone Ventilation) would supply as good air for breathing purposes as a system using all outside air. In actual practice however, and particularly in our cities, installation after installation has proven that Ozone Ventilation supplies not only as good air, **but in all cases better air** than that furnished by the old system.

The reason for this is apparent when it is considered that the outside air passes over our alleys, streets and chimneys,



Lincoln Theatre, Lincoln, Neb.

and carries with it into the ventilating systems particles of garbage, manure, smoke and other filth. Air washers and filters remove a large portion of the foreign matter, but the bacteria, odors, etc., are carried through the air conditioning apparatus and discharged into the various rooms. Treating this air as it leaves the filters or air washers with Ozone eliminates these deleterious elements and in this way actually improves the quality of the air.

Air tests made in Ozone Ventilated buildings show uniformly favorable results. Figure 1 is a reproduction of a Synthetic Air Chart, plotted from a test installation of Ozone Ventilation in a twenty-four room school building, operating under the split system and without an air washer. This method, developed by Dr. E. V. Hill, of Chicago, is accepted by the American Society of Heating and Ventilating Engineers as the standard method of testing air. Its principle is a plotting of each of the known factors affecting the air condition, such as dust, odors, etc., with regard to their percentage of perfect in the air tested.

On the Chart, the heavy black columns represent the unfavorable percentage of Dust, Bacteria, Odors, and CO₂. This chart is typical of those plotted from Ozone Ventilating systems. The percent of perfect of this system was 93.8, and when it is considered that the average for systems taking all outside air is 90 per cent, the quality of air supplied by Ozone Ventilation can more readily be appreciated.

THE EFFECTS OF OZONE VENTILATION

The practically complete absence of odors which Ozone Ventilation affords is believed responsible for the favorable effects noted on the health of the occupants of Ozone Ventilated buildings. It is unnecessary to go into the evils of

Fig. 1

SYNTHETIC AIR CHART

FOR DETERMINING THE PERCENTAGE OF PERFECT VENTILATION

TEMP HUMIDITY AIR MOTION WET BULB DIFFERENCE		DUST PARTICLES PER CU.FT.		BACTERIA COLONIES TWO MIN. PLATE		ODORS PERCENT FREE FROM		CO ₂ PARTS PER 10,000		DISTRIBUTION PERCENT		PERCENT OF PERFECT	
+%	-%	+%	-%	+%	-%	+%	-%	+%	-%	+%	-%		
	15	40	150,000	70	150	15	0	15	54	15	50	15	0
8°													
	14				14			14			14		
85								85					10
7°		50											
	12				12		20	12	44	12	60	12	20
6°													30
	10	60	100,000	10	80	100	10	10		10	10		
90	5°						40	90	34		70		40
	8				8		8			8	8		
4°		70											50
	6				6		60	6	24	6	80	6	60
3°		80	50,000	90	50								
95								95					70
2°	4				4		4			4	4		
							80		14		90		80
1°	2				2		2			2			90
100		100		0	100		0	100		0		0	

LOCATION _____ PUBLIC SCHOOL DATE 4-18-22 (93-8)%

PRIMARY SENSE IMPRESSION Good

WEATHER CONDITIONS

WET BULB 46.5° DRY BULB 54° RH% 54 WIND W DIRECTION W VELOCITY 13 MILES PER HOUR

NOTES OZONE GENERATED TEST BY _____

MODERN MECHANICAL TUNNEL SYSTEM PLOTTED BY DR. E.V. HILL

CHECKED BY _____

DESIGN & COPYRIGHT E.V. HILL

OZONE PURE AIRIFIER COMPANY, CHICAGO

shallow breathing farther than to point out the cause of this habit. The reader has doubtless noticed that in stuffy or odor bearing air, his own breathing is sub-consciously curtailed, and that it requires a very pronounced effort to force the lungs to take in their full capacity. Ozone Ventilation, because it supplies odorless air and eliminates any odor accumulation in the building, itself, removes the cause and prevents the formation of this harmful, sub-conscious habit.

Two benefits in particular have been noticed as characteristic of practically every Ozone Ventilating installation.

One very favorable reaction of the occupants of Ozone Ventilated buildings has been almost unanimously noted by teachers in Ozone Ventilated schools, who report a complete absence among their pupils of the familiar "mid-afternoon fatigue." They report that the pupils no longer show the dullness and lack of concentration formerly present after the lunch hour and in the middle of the afternoon.

Another result of Ozone Ventilation has been a consistent report from Ozone

Ventilated schools of increased attendance and decreased sickness, and particularly a decrease in affections of the lungs and throat, such as colds and bronchial troubles.

Reports of these two results have been too frequent and consistent to allow them to be attributed to coincidence or any other cause than Ozone Ventilation, itself. The actual cause of these favorable effects, however, is now attributed to the odorless air supplied by Ozone Ventilation, rather than any tonic or medicinal properties that the gas might possess. It is also significant that in the hundreds of installations, both portable and permanent, where the Ozone Generation has been under control, we have never received a report complaining of any ill effects from this system.

THE SIMPLE INSTALLATION AND LOW INSTALLATION COSTS

The installation of Ozone Ventilation does not mean the elimination of the mechanical equipment required under the ordinary system of ventilation. On the contrary. Ozone Ventilation requires all the other ventilating equipment, plus an Ozone Generator, which must be added to correct the faults that the existing equipment cannot be expected to overcome.

The installation costs of the Ozone Generator are so small as to be almost negligible, amounting only to the cost of running electric service wires to the machine, and galvanized piping from the machine to the air supply fan. Figure 2 shows the battery of Ozone Generators installed in the Cleveland High School, St. Louis, Missouri, one of the most completely equipped school buildings in the country. Note the very simple arrangement of this installation and the freedom from complicated piping and wiring.

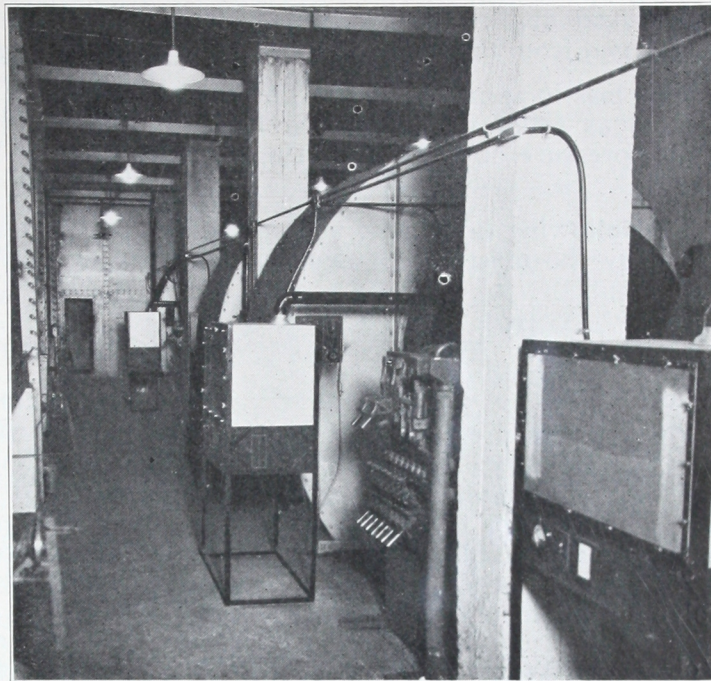
The ventilating system itself must, of course, be arranged for recirculation of air, but since the majority of ventilating



Missouri Athletic Association, St. Louis, Mo.

OZONE PURE AIRIFIER COMPANY, CHICAGO

Figure 2
Showing battery
of our
Ozone Generators
in
Cleveland High School
St. Louis, Mo.



systems are so arranged there is no expenditure necessary to revamp the system. Since the most economy is realized by recirculating the air, it is advisable that a system not so arranged be altered to accommodate recirculation. However, it is not necessary to recirculate to enjoy the benefits derived from Ozone. Recirculation is practiced and advised from the economic standpoint.

Our Engineering Department is maintained to advise building owners as to the advisability and cost of such a change, and they will be glad to cooperate with any school board, building owners, or parties interested in such work.

ORDINARY SYSTEMS WASTEFUL

The wastefulness of the ordinary systems may be understood easily by considering air movement in a building under the plenum system of ventilation. Air from the outside is drawn into the fresh air chamber, through the heating coils and into the fan, which forces it through the duct system into the rooms

at the grille openings. The air then passes through the rooms, is forced into ducts again and thence to exterior outlet where it is discharged from the building.

Now consider the temperature changes it undergoes in its course. Assume that the building is operated under the "split system," there enough direct radiation is supplied in the rooms to compensate for the wall and window losses. Air enters the heating coils and must be raised from the outside temperature to about 80° Fahrenheit. In the duct system, between the fan and the rooms, there is a temperature drop, generally about 10°, and consequently it is delivered to the rooms at a 70° temperature. Then between the rooms and the exterior outlet there is another drop of about 10°, and the air is discharged to the outside at about 60° F.

Now assume that the outside temperature is 20° Fahrenheit. It can be readily seen that only twenty degrees, or only one-third of the heat applied for ventilation is actually used in the building and that forty degrees, or two-thirds

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of the heat applied was wasted, being discharged from the building.

This loss in terms of fuel can be calculated as follows, assuming a barometric pressure of 29.92, and using dry air.

The following laws have been established by the most recent experiments with air:

$$\frac{PV}{T} = .754$$

Where

P = Absolute pressure of dry air, in. of mercury

T = Absolute temperature of air, deg. Fahrenheit.

V = Volume of 1 lb. dry air.

.754 = A constant.

Solve for volume

$$\text{Vol.} = \frac{.754 (459.6 + 60)}{29.92} = \left\{ \begin{array}{l} 13.10 \text{ cu. ft.} \\ 1 \text{ lb. dry air} \end{array} \right.$$

Heat content per cu. ft.

$$H = \frac{C (T_2 - T_1)}{V}$$

H = Heat content

C = .24. mean specific heat of air at constant pressure between temperatures (T_1 and T_2).

T_1 = Initial temperature deg. F.

T_2 = Final temperature deg. F.

V = Volume of 1 pound of dry air at 60° F.

$$H = \frac{.24 (60 - 20)}{13.10}$$

Or for every cu. ft. of air used, there is a heat loss of .735 Btu's / cu. ft. / min.

In a 10 hr. day this represents a loss of 441 Btu's / cu. ft.

With a B. F. G. efficiency of 70%, using coal with a heat value of 12,000 Btu's per pound the loss is:

$$\frac{441}{12,000 \times .70} = \left\{ \begin{array}{l} .0525 \text{ lbs. of coal for each} \\ \text{cu. ft. of air changed per} \\ \text{min. for a period of 10 hrs.} \end{array} \right.$$

If the heating plant was used 180 days the loss in a small building, where the air is changed at the rate of 10,000

cu. ft. per min. would be 94,500 lbs. of coal using dry air.

In a large building, where 300,000 cu. ft. of air per min. is circulated, this represents a tremendous loss in dollars and cents. At lower temperatures and when the heat required to raise the temperature of the moisture present, due to humidity, is considered, it is self evident the loss would be considerably greater.

HOW OZONE SAVES FUEL

To demonstrate how a saving in fuel is effected, compare with the preceding case, a building operating under Ozone Pure Airifier system of ventilation. There is practically no difference in the mechanical arrangement of the two systems when designed for recirculation. However, with the Ozone Ventilating system the intake port is partially closed (with an adjustable damper) admitting only a part of its normal capacity. This air is drawn thru heating coils, and passes thru the circulating fan into the ducts as before. The balance of the air circulated is warm air discharged from the rooms. This warm air passes thru a duct where it is treated with Ozone, deodorizing, purifying and revitalizing it. This air then passes into the fan and is recirculated. Thus the valuable heat units, which formerly were wasted, are saved.

Consider again the temperature changes of the air. Obviously, the losses are the same in both systems. The air returns thru the duct at a temperature of 60 degrees F. If 50% of the air is recirculated and mixed with the air entering thru the fresh air chambers, the resulting temperature of the air delivered to the heating coils is about 40 degrees Fahrenheit.

Compare this with the 20 degree air delivered to the heating coils under the old system, and it will be readily seen that under the Ozone Ventilation System, the temperature need only be raised from forty to eighty degrees, whereas, where all outside air is used, the tem-

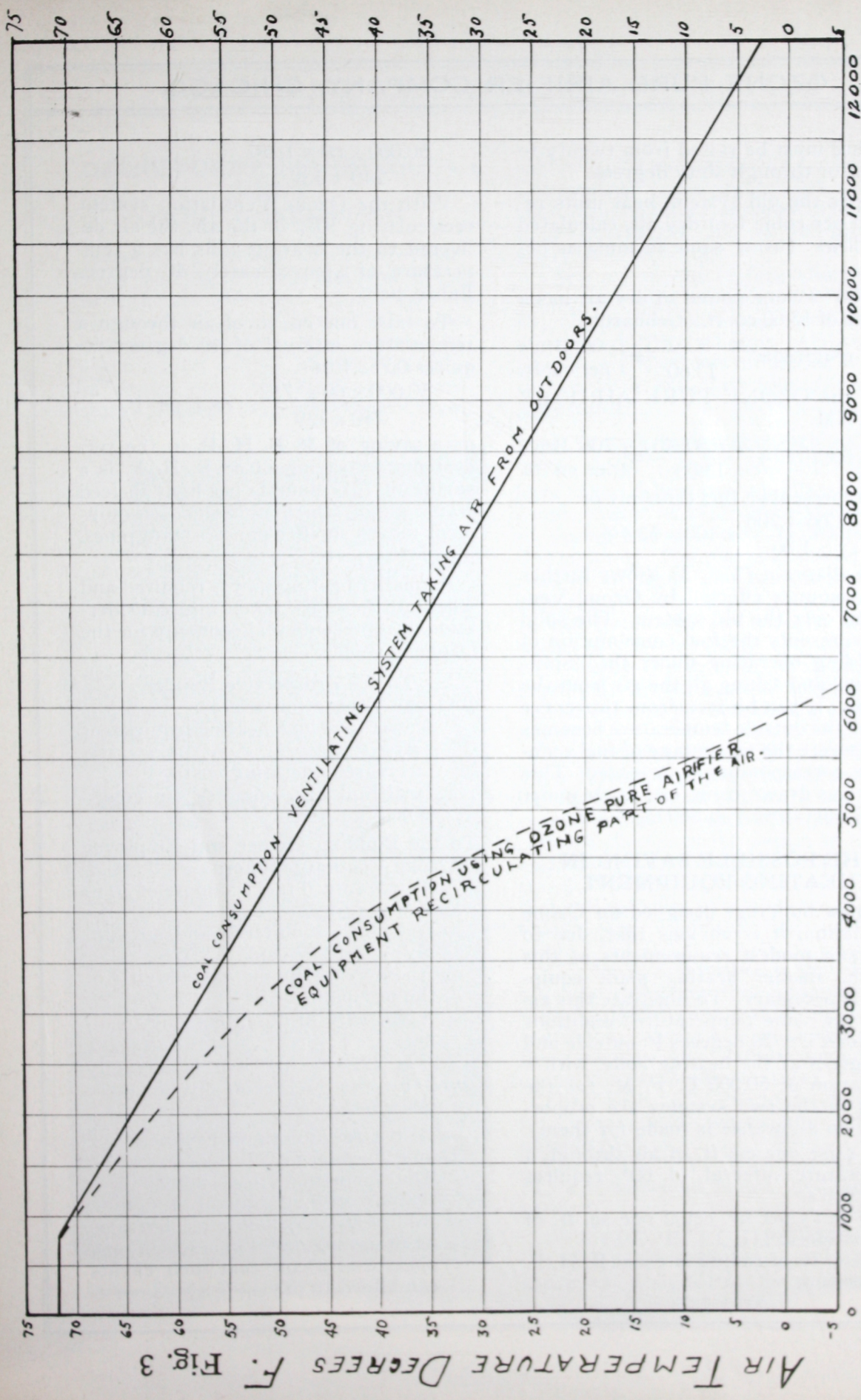


Fig. 3. AIR TEMPERATURE DEGREES F.

COAL CONSUMPTION PER 10 HOUR DAY IN POUNDS

KEY { ---OLD SYSTEM, AIR TAKEN FROM OUT DOORS
 ---OZONE SYSTEM, RECIRCULATING 75% OF THE AIR

OZONE PURE AIRIFIER COMPANY, CHICAGO

perature must be raised from twenty to eighty, or **through sixty degrees.**

Under the old system, heat units required per cubic foot dry air, calculated as follows: (using same formula as before).

At 80° F. one pound of dry air has a volume of 13.60 cu. ft. (Gebhardt).

$$\text{Heat required} = \frac{.24 (80-20)}{13.60} = \left\{ \begin{array}{l} 1.06 \text{ Btu's} \\ \text{per cu. ft.} \end{array} \right.$$

With the OZONE PURE AIRIFIER SYSTEM.

$$\text{Heat required} = \frac{.24 (80-40)}{13.60} = \left\{ \begin{array}{l} .706 \text{ Btu's} \\ \text{per cu. ft.} \end{array} \right.$$

This represents a fuel economy of

$$\frac{1.06 - .706}{1.06} \times 100 = 33.4\%$$

The diagram (Fig. 3) shows further the economies effected by Ozone Ventilation over the old system. The solid line represents the fuel consumption of a building operating under the "Split-System" and taking all the air from the outside. It can be seen from this curve that as the outside temperature becomes more severe the percentage of fuel economy is correspondingly increased. This curve was drawn from tests made under actual operating conditions.

THE POSSIBLE SAVING IN HEATING EQUIPMENT

In new buildings designed for Ozone Ventilation, it is obvious that, due to the more modest requirements of this system, smaller heating plant equipment is necessary. To illustrate this assume the same temperature conditions as before, i. e. 20 degrees F. outside and 80 degrees at the heating coils, with a circulation of 50,000 C. F. M. (as the losses in the two systems are proportional no allowance is made for them).

To raise one cu. ft. of air through a temperature interval of 60° requires 1.181 Btu's.

240 Btu's per hr. equal one sq. ft. of radiation.

139 sq. ft. of radiation equal B. H. P. Therefore

$$\frac{50,000 \times 60 \times 1.181}{240 \times 139} = 106 \text{ B. H. P.}$$

With the Ozone Ventilation system, recirculating 50% of the air, the air delivered to the heating coils has a temperature of approximately 40 degrees Fahrenheit.

To raise one cu. ft. of air through a temperature interval of 40 degrees requires 0.752 Btu's.

$$\frac{50,000 \times 60 \times .752}{240 \times 139} = 68 \text{ B. H. P.}$$

or a **saving of 38 B. H. P.** in the two systems. A saving of 38 B. H. P. is a saving of 1311 pounds per hour in feed water all of which in terms of equipment means smaller pump, steam pipes, pipe fittings, etc.

A smaller heating unit is required and when all these are taken into consideration, it represents real economy for the Ozone system.

To the Prospective Builder

Ozone Ventilation offers—

Lower original heating equipment costs—

Decreased operating costs—

Healthful and odorless air conditions.

To the Building Owner and Employer

Ozone Ventilation offers—

A guaranteed fuel economy of 30 to 40%—

An odorless building and air supply—

An increase in mental activity of the occupants—

A decrease in absentees due to illness—

All at a cost that will be actually saved by the fuel economy in three months time or less.

To the Architect and Engineer

Ozone Ventilation offers—

The opportunity of establishing a reputation, not only of designing well ventilated buildings, but also of designing buildings which will operate at a cost that their clients can afford to pay.

OZONE PURE AIRIFIER COMPANY, CHICAGO

OZONE PURE AIRIFIER EQUIPMENT OZONE GENERATION

Ozone is generated most economically by passing a small amount of air through an electrical discharge. A simple ozone generator consists of two electrodes separated by a dielectric. When a high voltage electric current is impressed upon the electrodes a discharge takes place between them,

similar to the discharge of a Leyden jar. Commercial ozone generators depend upon this fundamental construction and their differences are in design and selection of materials.

There are several factors which cause the ozone output of a generator to vary. Principally, the watt input and the relative humidity of the air entering the generator. The current input is controlled by a rheostat; humidity by a dehydrator.

THE IDEAL OZONE GENERATOR

The ideal ozone generator should have the following qualities, some simple means of controlling the output of ozone, and adequate regulation of this control. The machine should generate a constant amount of ozone at each regulation point. Its construction should be simple and rugged and so designed that all parts are accessible and readily dissembled. It should be provided with some means by which the machine would be assured of a clean air supply.

It is toward this ideal that the Ozone Pure Airifier Company has been striving for the past fifteen years. It is recognized that for each different application a change in the design of a generator may be necessary. However, two standard machines have been designed that will satisfactorily take care of practically every condition in ventilation work.

This bulletin describes in part the details of ozone generating equipment, designed especially for installation where continuous operation, combined with the assurance of a definite amount of ozone are paramount features.

The TYPE "E" Generator—designed for installations where the relative humidity is low.

The TYPE "EV" Generator—designed for installations where the humidity varies.

TYPE "E" EQUIPMENT

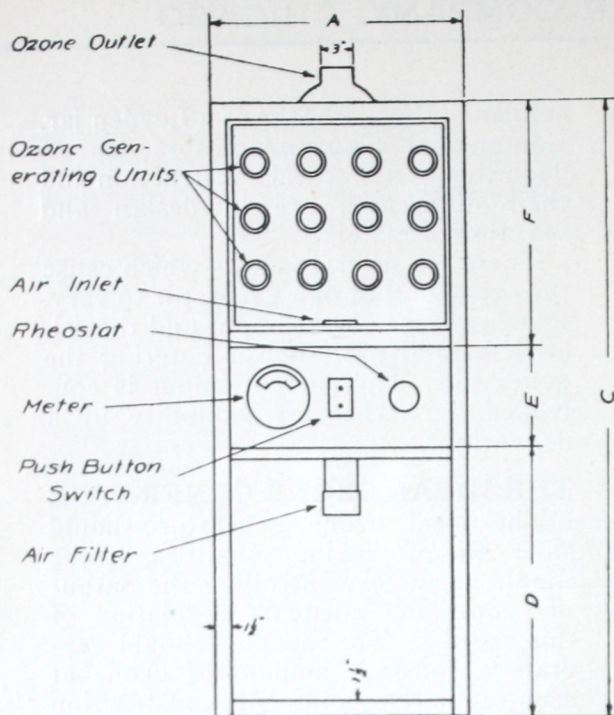
The TYPE "E" equipment as stated above was designed for continuous ser-

(Continued on page 18)

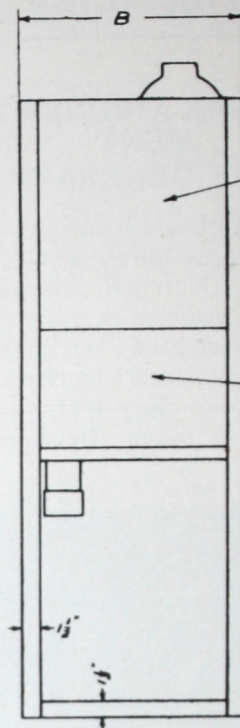


Orpheum Theatre, Chicago, Ill.

TYPE "E"

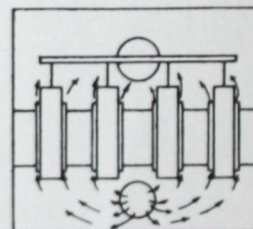


Front View
(Door removed)



Side View.

DIMENSIONS AND GENERAL SPECIFICATIONS										
STYLE	AIR CAPACITY	NO. OF UNITS	WATTS MAX (2)	DIMENSIONS						WEIGHT (APPROX)
	CFM			A	B	C	D	E	F	
E-3	10000	3	54	23 1/2"	20 1/2"	50 1/2"	29 1/2"	9 1/2"	11 1/2"	125 lb.
E-5	15000	5	90	23 1/2"	20 1/2"	50 1/2"	29 1/2"	9 1/2"	16 1/2"	135 "
E-9	27000	9	162	23 1/2"	20 1/2"	55 1/2"	29 1/2"	9 1/2"	21 1/2"	160 "
E-13	40000	13	234	28 1/2"	21 1/2"	55 1/2"	29 1/2"	9 1/2"	21 1/2"	180 "
E-16	50000	16	288	28 1/2"	21 1/2"	60 1/2"	29 1/2"	9 1/2"	26 1/2"	200 "
E-21	65000	21	378	32"	21 1/2"	60 1/2"	29 1/2"	9 1/2"	26 1/2"	220 "
E-25	80000	25	450	32"	21 1/2"	65 1/2"	29 1/2"	9 1/2"	31 1/2"	240 "



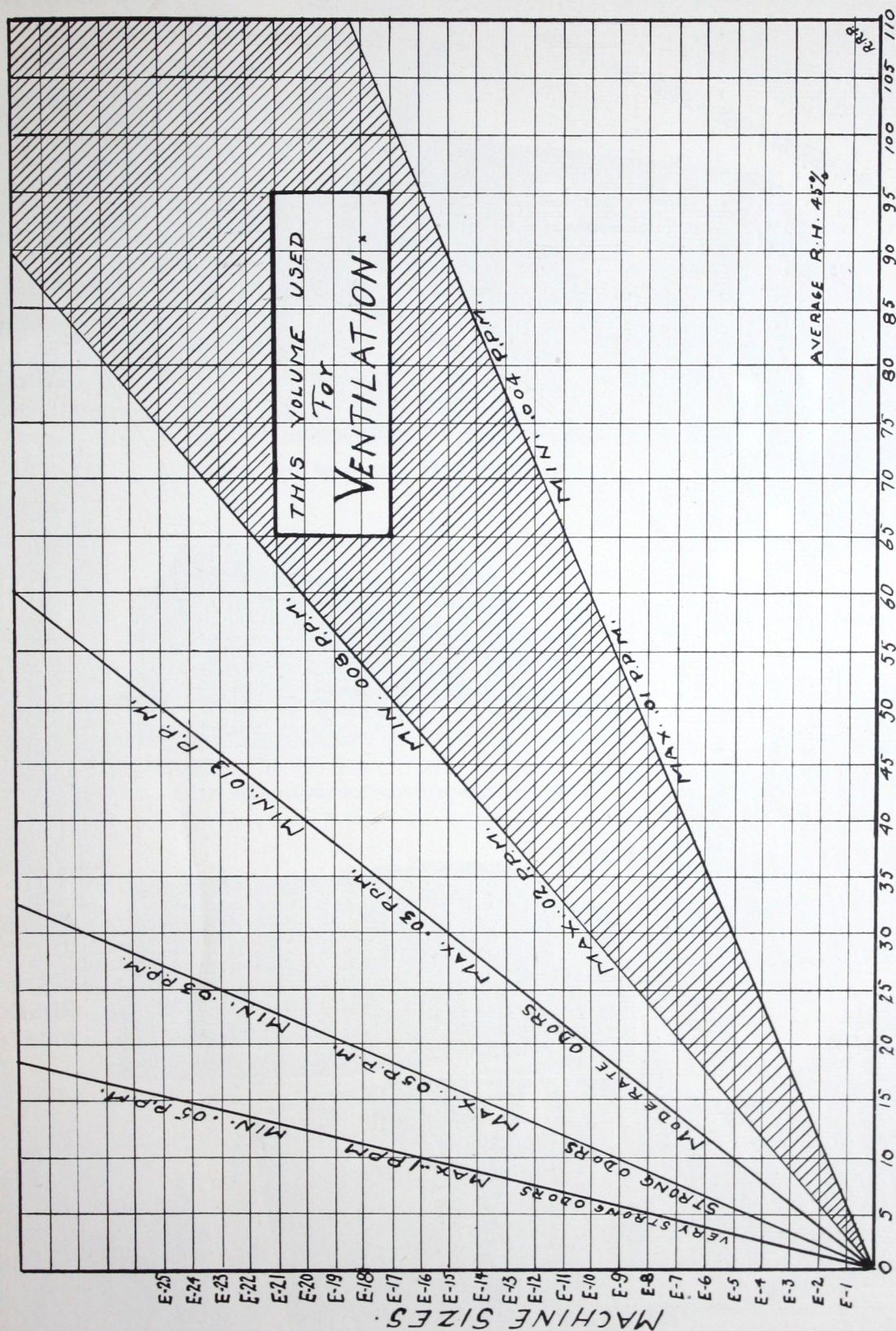
Top section of Ozone generating cabinet showing partitions, arrangement of cylinders, and direction of air currents.

1 Machines with capacities between sizes listed above take the next smaller frame.

2 AC watt consumption approximately 18 watts per unit.

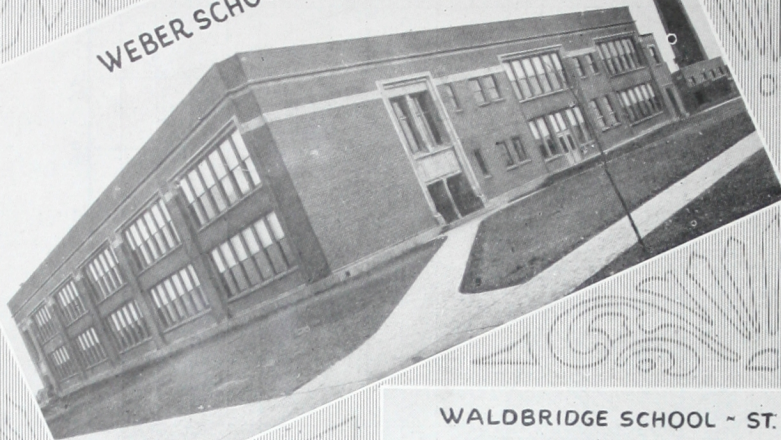
3 The figures in the above table are for AC. For DC, E-5 and smaller, add 80 watts and 35 lbs. E-6 to E-16 add 150 watts and 100 lbs.
E-17 - E-25 - 300 - - 150 -
E-26 - E-50 - 500 - - 200 -

4 Machines larger than E-25 are built in two complete machines, but with one control rheostat, and enclosed in the same cabinet.



C. F. M. IN THOUSANDS
TYPE "E" EQUIPMENT

WEBER SCHOOL ~ SAGINAW, MICH.



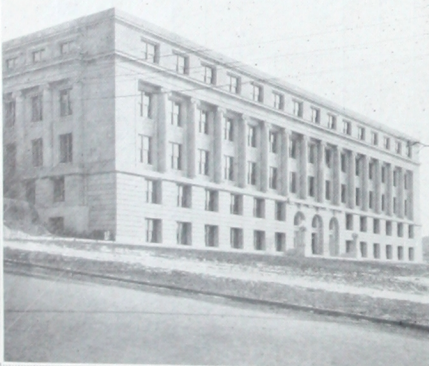
SOLDAN HIGH SCHOOL



WALDBRIDGE SCHOOL ~ ST. LOUIS, MO.



RECITATION BLDG. ~ IOWA CITY



JOSEPH CANNON SCHOOL ~ DANVILLE, ILL.



OZONE
PURE AIR
IS A
SUCCESS
IN OUR
FINEST
SCHOOL
BUILDING

ROSLYN SCHOOL
MONTREAL, CAN.



WINONA STATE TEACHERS' COLLEGE



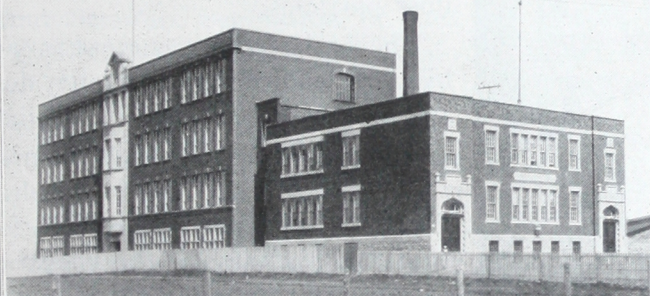
SCHOOL ~ ST. LOUIS, MO.



CENTRAL JUNIOR HIGH SCHOOL ~ SAGINAW, MICH.



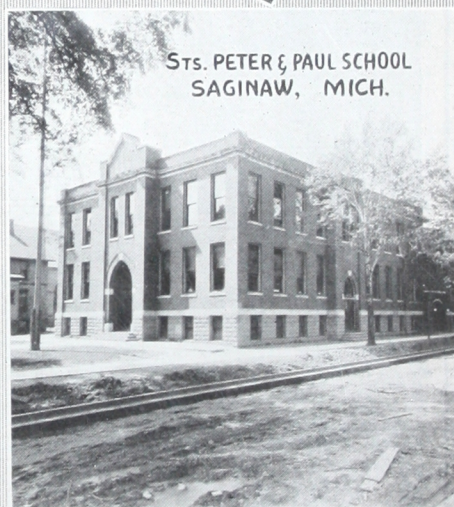
ROSEMOUNT SCHOOL ~ MONTREAL CAN.



WALNUT PARK SCHOOL ~ ST. LOUIS, MO.



ST. PETER & PAUL SCHOOL
SAGINAW, MICH.



HIGH SCHOOL
DANVILLE, ILL.

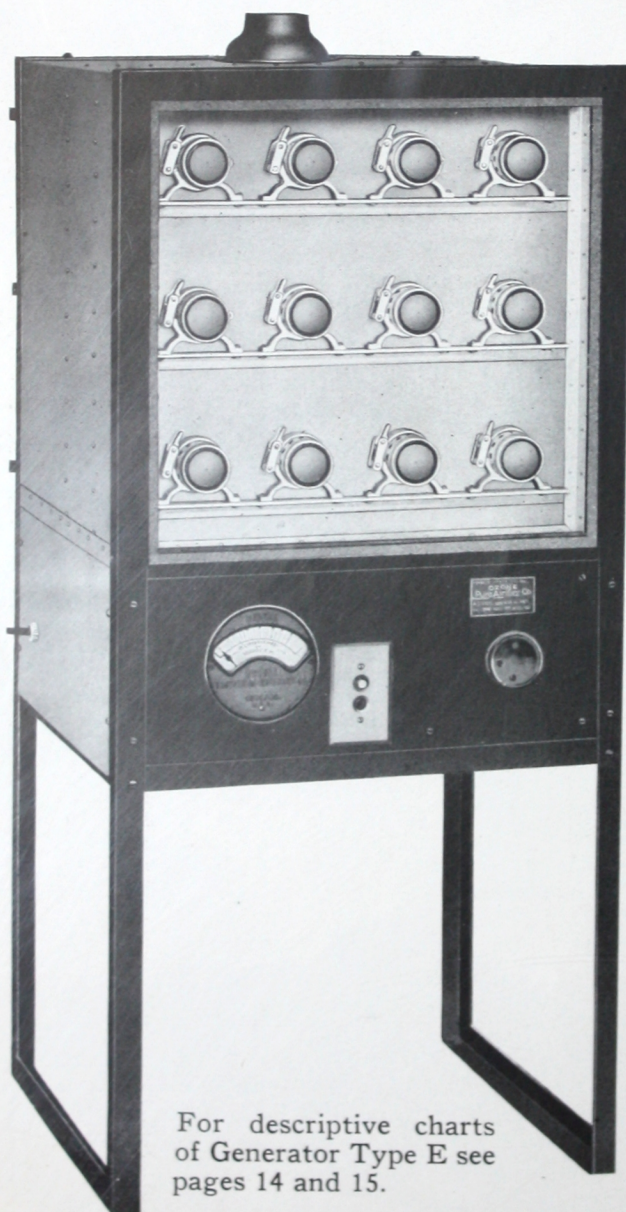


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UILDINGS

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OZONE PURE AIRIFIER COMPANY, CHICAGO

vice under practically constant, low relative humidity conditions. The machine stands approximately fifty-five inches high, varying of course with the number of generating units enclosed. The cabinet is constructed of aluminum, divided into two compartments. The upper compartment contains the generating units, the lower compartment, the transformer, rheostat, fuse block and meters.



For descriptive charts of Generator Type E see pages 14 and 15.

The generating unit is cylindrical in shape and consists of an aluminum exterior electrode, a special lead free glass dielectric and an interior electrode. The interior electrode is electrolytically deposited upon the surface of the glass dielectric. The units are supported in the cabinet by two aluminum baffles which direct the air going through the machine into the units, automatically cooling them. Each unit is attached to the baffles by means of a clamping device which allows the convenient removal of any unit. The air intake is provided with a filter to remove the dust particles.

The high voltage current is supplied by a transformer, especially designed and manufactured for this peculiar load.

The output is controlled by means of a rheostat, which varies the voltage on the primary side of the transformer. Graduated points on the rheostat provide a very adequate control of the output.

A meter and conversion table are supplied in front of the machine from which the amount of ozone being generated at any time can be determined at a glance.

Installation of the machine is a very simple matter. The machine comes assembled ready for operation, all that is necessary being to make the electrical connection, and to connect the Ozone outlet of the machine to the intake side of the circulating fan. When the fan is put into operation, it creates sufficient suction to draw the ozone from the machine and the installation is complete.

TYPE "EV" EQUIPMENT

Type "EV" equipment is designed for installations where the relative humidity varies or where there is an excessive amount of moisture in the air.

OZONE PURE AIRIFIER COMPANY, CHICAGO

The presence of dirt and moisture in the air also curtails the production of ozone by changing the characteristics of the electric discharge. The type EV generator as manufactured by the OZONE PURE AIRIFIER COMPANY is provided with a means of conditioning the air before it enters the generating units, i. e., comes in contact with the electric discharge. A system of dehydration and filtration removes all dirt and at least 95% of the moisture from the air before it passes through the generating units. With clean and practically dry air supplied to the generating units, an adequate and accurate regulation of the ozone production is effected by the variation of the voltage. The voltage is regulated with a rheostat that has a range from 25% to 100% of the maximum. (A potential equivalent to 25% of the line voltage is required to overcome resistance of the air gap between the exterior electrode and the dielectric.)

DETAIL OF OPERATION

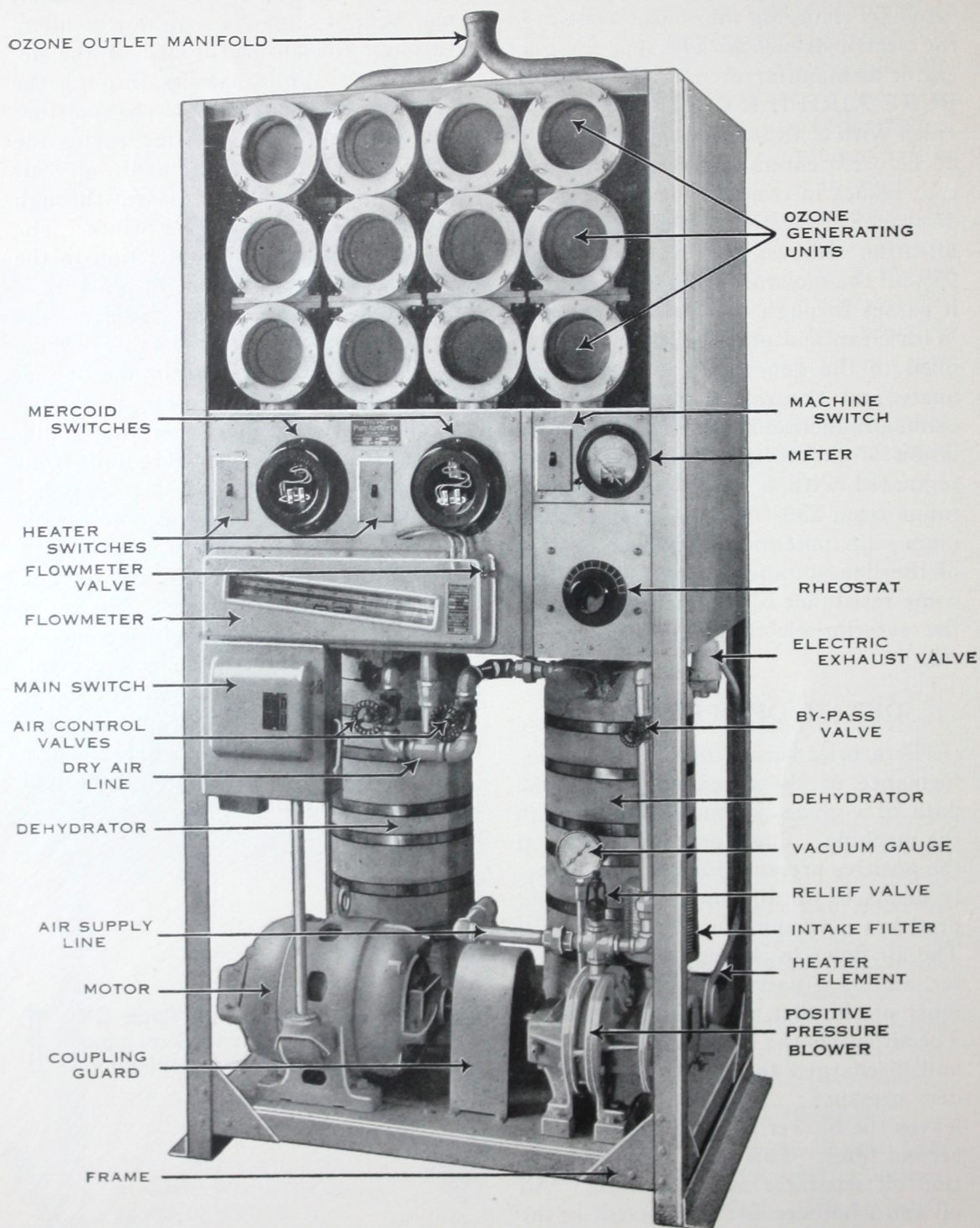
For a brief survey of the entire performance of the assembly, follow the path of a given volume of air through the machine. The motor is started and the positive pressure blower immediately displaces all air contained in it and produces a vacuum on the intake side. The air flows in through the intake filter, and as it passes through the filter, most of the dirt and dust is removed. The air enters the blower, is compressed and discharged through the outlet under pressure. Immediately after it leaves the blower it passes through the second filter. This filter is a combination oil separator and dust filter. All oil and whatever dirt are present in the

air are retained by this filter. From the filter the air passes into the dehydrator, and here it expands and slowly filters through the absorbent bed of the dehydrator. While passing through the dehydrator, about 95% of the moisture content is absorbed. After leaving the dehydrator the now practically dry air enters the dry air line, passes through the control valve into the orifice. The orifice offers a slight restriction to the air flow, and a difference in pressure is produced that manifests itself in the flowmeter by indicating the rate of flow. The air next enters the intake or distributing manifold, where it is divided equally between the generating units. The air enters the generating units from the front end and is forced to pass between the exterior electrode and the dielectric. Here it comes in contact with the high tension discharge, and oxygen is broken up to form ozone. The ozone is forced out at the rear of the generating units, and into the collecting manifold, where it combines with the ozone from the other generating units. From the collecting manifold it enters the pipe lines and is distributed to the desired points of application.

⌈ (For description of Type EV Generator, illustrated on page 20, see pages 21 and following) ⌋

Ozone Pure Airifier Co.

TYPE EV 12



OZONE PURE AIRIFIER COMPANY, CHICAGO

TYPE EV GENERATOR

Detailed Description of Illustration on Page 20

OZONE GENERATING UNITS:

Each generating unit consists of dielectric and two electrodes. The dielectric is a special, cylindrically shaped glass with an insulation strength of 50,000 volts at 60 cycles.

The inner electrode is copper electrolytically deposited upon the glass.

The exterior electrode is aluminum clamped around the glass but not in actual contact with it.

When a high tension electric current is impressed upon the dielectric, a peculiar discharge takes place. This discharge is known as a "brush discharge" and is the medium by which ozone is formed.

The entire unit is enclosed in a cast aluminum housing that is capable of withstanding a high internal pressure. The front of the housing is closed with a cover that contains a large vision glass. Through the vision glass the operation of the generating unit may be seen.

A large insulator is mounted on the opposite end of the housing. This insulator is hand made of high grade, glazed porcelain. It is moisture proof and has an electrical resistance of 100,000 volts. This insulator is practically indestructible under ordinary conditions, and will meet requirements of the underwriter's specifications. Through the center of the insulator runs the conductor for the high tension current. One end of the conductor terminates at the contactor for the inner electrode. The opposite end terminates at the busbar on the secondary side of the transformer. The complete assembly is air tight and will withstand an internal pressure of 75 pounds

per square inch without leaking. The generating unit and its housing is so constructed and assembled that it can be dismantled by removing 4 wingnuts on the front cover.

OZONE OUTLET MANIFOLD:

On all multiple unit generators of this type, the outlet of each individual generating unit or tier of units discharges into a manifold. This manifold is made of cast aluminum and the outlet of the manifold is tapped with a standard pipe thread. The intake side of the generating units are connected by the same type of manifold for distributing the dry air supply.

TRANSFORMER: The transformers are enclosed in the center compartment. They are manufactured in our own plant and are designed with certain features to compensate for the high inductive load of the generating units. The laminations for the cores are made from the highest grade silicon steel. These transformers are oil cooled and have an electrical efficiency of 98%.

CONTROL PANEL: The control panel contains the instruments and apparatus necessary for controlling and regulating the entire machine. The flowmeter, mercoid switch, rheostat, meter, heater switch and machine switch are all mounted on it.

FLOWMETER: A flowmeter indicates the rate of air flow through the dehydrators. It is an inclined meter for flows corresponding to a maximum differential pressure of $1\frac{1}{2}$ inches of water. The meter scale is calibrated in percent capacity (0% to 100%), and is provided with a meter factor which

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translates percentage reading into cubic feet of air per minute.

FLOWMETER VALVE: The link valve is an integral part of the flowmeter and permits a zero adjustment, draining or filling while the meter is in operation.

MERCOID SWITCH: The mercoid switch automatically controls the reactivation of the dehydrators. They consist of a mercury tube switch, mechanically operated with a thermostat as a motivator. The thermostat is installed in the dehydrators and has a flexible tube connection with the switch on the panel. The switches are equipped with a hand re-set as an additional means of protection, and are re-set when desired by applying a slight pressure to the re-set contact.

RHEOSTAT: The rheostat is constructed of the highest grade nicrome wire, and has a sufficient capacity to carry a 100% overload without injury. Ozone production is a function of the voltage and the rheostat permits a regulation from 25% to 100% of the maximum ozone output.

METER: Each machine is equipped with a standard high grade meter. As the ozone production is a function of the voltage, the meter can be calibrated to read directly in grams or milligrams of ozone per minute.

HEATER SWITCH: The heater switches are manual controls for the current supplied to the heater elements.

MACHINE SWITCHES: The machine switch controls the current supply to the transformer. It is connected through the main supply switch, so that the generating units cannot be operated independently of the positive pressure blower, as it is imperative that air be

supplied to the generating units whenever the high tension current is turned on. Should it ever become necessary, this switch permits simultaneous reactivation of the dehydrators.

MOTOR: Wherever possible, repulsion type, slow speed motors are used; they are directly connected by a flexible coupling to the positive pressure blower.

POSITIVE PRESSURE BLOWERS: An ordinary fan or blower does not deliver air with enough pressure to overcome the restriction in the dehydrator and the pipe lines. Therefore a positive pressure blower is required. These positive pressure blowers are designed for continuous operation under a pressure of five pounds per square inch. Ordinarily only 1½ to 2 pounds pressure per square inch is required to overcome the friction in the pipe lines and the dehydrator. The surplus pressure range allows a large margin of capacity for the blower without danger of overloading.

INTAKE FILTER: This filter is installed on the intake side of the blower and all air used by the machine must pass through this filter. It is a dry type, constructed with a special insert, that presents a maximum surface to the air flow, enclosed in an aluminum shell. With ordinary air this filter requires very little attention. The filter is cleaned by reversing the direction of air flow. This is accomplished by attaching an air hose or automobile tire pump, to a special stem provided for this purpose.

VACUUM GAUGE: The vacuum gauge is a protective device, located on the suction side of the blower to indicate the suction head of the blower. When dirt and dust collect on the filter the suction head increases, which in turn will increase the load on the motor. As the suction increases, it is indicated on the vacuum gauge, which is marked

OZONE PURE AIRIFIER COMPANY, CHICAGO

at a certain point to show that the filter must be cleaned to prevent overloading.

RELIEF VALVE: The relief valve is on the discharge side of the blower. In case a restriction occurs anywhere in the pipe lines, the excess pressure will have a chance to escape, and in this manner prevent overloading of the motor due to excessive pressure on the blower.

AIR SUPPLY LINE: This pipe line handles the air displaced by the blower. It is divided into two parts; one part leads to the negative side of the dehydrators; the other carries the surplus air around the machine, and is called the "by-pass."

BY-PASS: Only a part of the air displaced by the blower is required by the machine for the generation of ozone. The balance is discharged through the by-pass. The by-pass leads this surplus air around the machine, and if necessary, discharges it into ozone outlet manifold. (In large installations it is sometimes necessary to use the surplus air to force the ozone through the pipe lines. In such a case the by-pass discharges into the manifold.)

DEHYDRATOR: The dehydrator is used to dry the air before it enters the generating units. (A complete description of the dehydration process will be found on page 24 and following, of this bulletin.)

DRY AIR LINE: The air, after leaving the dehydrators, flows through the dry air line into the generating units. In this pipe line, concealed in the center compartment, is the orifice for the flowmeter.

AIR CONTROL VALVES: These valves are located in the dry air line to regulate the air flow through the dehydrators. The rate of flow is indicated by the flowmeter and can be increased or decreased as desired by turning these

valves. During reactivation the control valve that corresponds to that particular dehydrator must always be closed.

HEATER ELEMENTS: The heating element terminals are enclosed in outlet boxes. The outlet boxes are securely fastened to a steel plate. The entire assembly can be readily removed by removing the plate. The elements are specially designed and particularly adapted for this dehydrator.

MAIN SWITCH: The power supply for the entire machine must pass through this switch. A constant supply of air is essential in the generation of ozone and also in reactivating the dehydrators; with this object in view, the wiring of the machine is so arranged that the motor (or main) switch must be closed before either process can be carried out.

ELECTRIC EXHAUST VALVE: The exhaust valve is normally closed, but during reactivation of the dehydrator the valve is opened to allow the moisture to escape. The valve is a solenoid type shunted across the supply line to the heating elements. When current is supplied to the elements the valve automatically opens and remains open until the mercoid switch breaks the circuit.

COUPLING GUARD: The motor and the positive pressure blower are directly connected by a flexible coupling. A guard is placed over the coupling as a protection for the coupling and as a safety device.

FRAME: The frame for this equipment is fabricated from steel, carefully reinforced to insure a solid substantial frame and to prevent vibration. The base is supported by the corner posts, 3 inches above the floor and is covered with a heavy sheet of boiler plate. The outside dimensions, measured from the corner posts, are 31 inches wide by 38

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inches long. The height over all varies from 72 to 85 inches, depending upon the number of generating units. The cross angle at the bottom of the corner posts is drilled for anchor bolts, should it be desired to anchor the machine.

DEHYDRATOR

The dehydrator is used primarily to remove the water vapor from the air that is to be passed through the Ozone Generating units. A second, but no less important use, is the removal of oil vapors and other organic vapors that are not intercepted by the filters. The organic vapors are the compounds that are usually electrically precipitated upon the dielectrics.

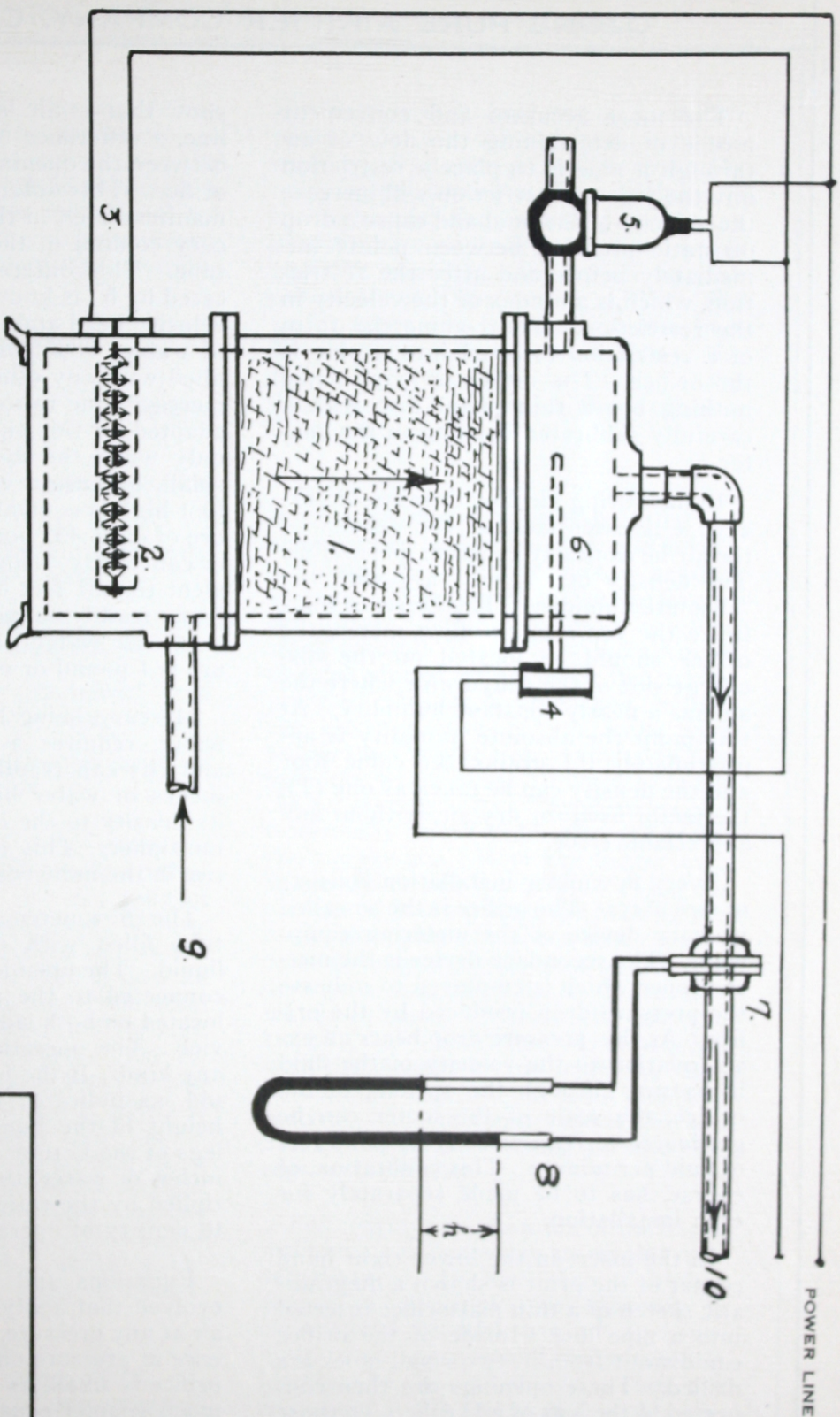
The dehydrator, as manufactured by the Ozone Pure Airifier Company, is filled with a porous granular compound, known by a trade name as "Silica Gel." Silica Gel is an artificially prepared form of pure silica, and when properly re-activated, will retain its absorption properties for an indefinite period. When used for water vapor absorption, it will take up 30% of its weight of water vapor and still remain sensibly dry. After being saturated with moisture, the compound is re-activated for further use by the application of heat. When properly re-activated at 600° F, silica gel will still retain about 5% or 6% of residual moisture, which should be deducted before any calculations are made regarding the amount of moisture it will absorb; which leaves, as a safe working figure, 20%, with a 4% or 5% factor of safety. Stated briefly, this means that each pound of silica gel in the dehydrator will absorb and retain 0.20 pounds or 1,400 grains of water. The rate of flow of air through a dehydrator has no effect on its efficiency up to 0.8 cubic feet of air per pound of gel per minute. Therefore, from the above figures, a small dehydrator containing 20 lbs. of silica gel will remove 4 pounds of water

vapor from the air passed through it; and deliver the same air with a moisture content of approximately 0.1 grains per cubic foot at about 10° above room temperature, when the rate of flow does not exceed 0.8 CFM per pound of gel.

The air can be passed through an absorber of this size at any rate up to 16 cubic feet per minute and still be discharged with a moisture content of 0.1 grains per cubic foot, until the saturation point is reached. Knowing that a dehydrator will absorb 4 pounds of water vapor, and that the limit of flow is not to exceed 16 cubic feet a minute, some plan must be worked out by which the maximum efficiency of the dehydrator can be obtained, at the same time not curtailing the efficiency of the rest of the equipment.

The most practical method is to assume a rate of flow of one cubic foot of air per minute through the dehydrator. From the psychrometric data of the U. S. Weather Bureau, the mean annual Relative Humidity for the district in which the machine is to be installed is found; also the highest, monthly average temperature of the year for a period of years.

By referring to a psychrometric chart or a steam table the amount of moisture necessary to saturate one cubic foot of air at the above temperature can be found. Then by knowing the average percent of saturation, (mean annual relative humidity) the amount of water present in each cubic foot of air can be calculated. From previous calculations the amount of the water that the dehydrators will absorb is known. This amount in grains divided by the number of grains of moisture per cubic foot of air will give the length of time in minutes that the dehydrator will operate before saturation. Divide the above result by sixty and the length of the cycle in hours is found.



DEHYDRATOR ASSEMBLY (SCHEMATIC)

1. DEHYDRATOR DRUM
2. HEATING ELEMENT
3. HEATER SUPPLY LINE
4. MERCROID SWITCH
5. ELECTRIC EXHAUST VALVE
6. THERMOSTAT
7. ORIFICE FLANGES
8. FLOW METER
9. AIR SUPPLY
10. DRY AIR OUTLET

OZONE PURE AIRIFIER CO., CHICAGO, ILLINOIS

OZONE PURE AIRIFIER COMPANY, CHICAGO

The most accurate and convenient means of determining the flow of air through a pipe is to place a restriction into the pipe. A restriction will increase the velocity of the fluid and cause a drop of static pressure between points immediately before and after the restriction, which is an index of the velocity in the restriction. The commercial form of a restriction inserted into a pipe is the orifice. The orifice is in principle nothing but a thin metal disc with a carefully calibrated opening in the center.

In measuring air flow to insure accuracy, it is essential that the density of the air be as nearly constant as possible. The density of air will vary with the "absolute humidity." Therefore, to minimize the error of the flow meter, the orifice should be located on the discharge side of the dehydrator where the air has a nearly constant humidity. At this point the absolute humidity is approximately 0.1 grains per cubic foot and the density can be taken as one (1), the factor used for dry air, without any appreciable error.

Every flowmeter installation consists of two parts. The orifice is the so-called primary device of the metering equipment. The secondary device is the meter proper which is employed to indicate the pressure drop produced by the orifice. As this pressure drop bears an exact relation to the velocity of the fluid in passing through the opening of the orifice, the scale of the meter can be graduated to read directly in cubic feet of fluid per minute. This calibration, of course, has to be made separately for each installation.

In the insert in the lower right hand corner of the print is shown a diagrammatic sketch of a thin plat orifice inserted into a pipe line. Inside of the orifice equidistant from it, two small holes are drilled. These openings are then connected to the legs of a U tube. To those unfamiliar with this, a careful study will

show that as air is passed through the line, a difference in pressure will exist between the opening on each side of the orifice. This difference in pressure will manifest itself in the height of the mercury column in the two legs of the U tube. This difference in height (indicated by h) is known as the dynamic or velocity head and is measured in inches of water. The tube can, of course, be filled with any other liquid desired, but mercury, due to its density, is the best adapted for this purpose. Water is used only when the dynamic head is quite small, because a column of water one foot high is equivalent to a static pressure of only .433 pounds per square inch, or conversely, 1 pound pressure is equivalent to 2.31 feet of water. Therefore, it can readily be seen that it is impractical to use water where the static pressure is 1 pound or more.

Mercury, being 13.6 times as dense as water, requires a tube much shorter, and (h) can readily be translated into inches of water by using the ratio of its density to the density of water as a multiplier. This is the common practice in the industrial world today.

The flowmeter is in principle a U tube filled with a suitable operating liquid. The open legs of the U tube are connected to the pressure connections located on both sides of the primary device. The operating liquid may be of any kind. If the head of operating liquid, as indicated by the difference of height of the liquid levels in the two legs of the U tube, shall be expressed in inches of water, the head must be multiplied by the ratio of density of water to density of operating liquid.

Equations and formulas have been evolved that apply to the measuring of air at any pressure, but where the difference in pressure on the two sides of the orifice is small, as it is in most cases, a much simpler equation may be used by making the assumption that there is no

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change in density as the air passes through the orifice. This assumption is permissible because in most cases the change in pressure is less than one inch of water, and the error introduced by this assumption is well within the limits of any measuring device. The formula reads as follows:

$$V = 4.133 KFR \sqrt{\frac{H}{d}}$$

Where **V**=Volume of air in cubic feet per second.

F=Area of the pipe in square feet.

R=Ratio of area of orifice opening to area of pipe.

K=Orifice coefficient, determined by experiments.

H=Indicating differential head in inches of water.

d=Density of air at point of measurement.

As previously stated, the flowmeter is in principle a U tube filled with a suitable operating liquid. For the sake of obtaining a clear indication of any change of the pressure drop across the orifice and hence of the rate of flow an inclined flowmeter is used, if the total pressure drop or differential through the orifice is 3 inches or less. The inclined flowmeter is nothing more or less than a U tube, the one leg of which is given definite inclination. The movement of the liquid in the inclined leg is magnified 8 or 10 times over the straight vertical movement, depending upon the angle of inclination. This inclination of the tube facilitates the reading of the meter and reduces the error to a minimum.

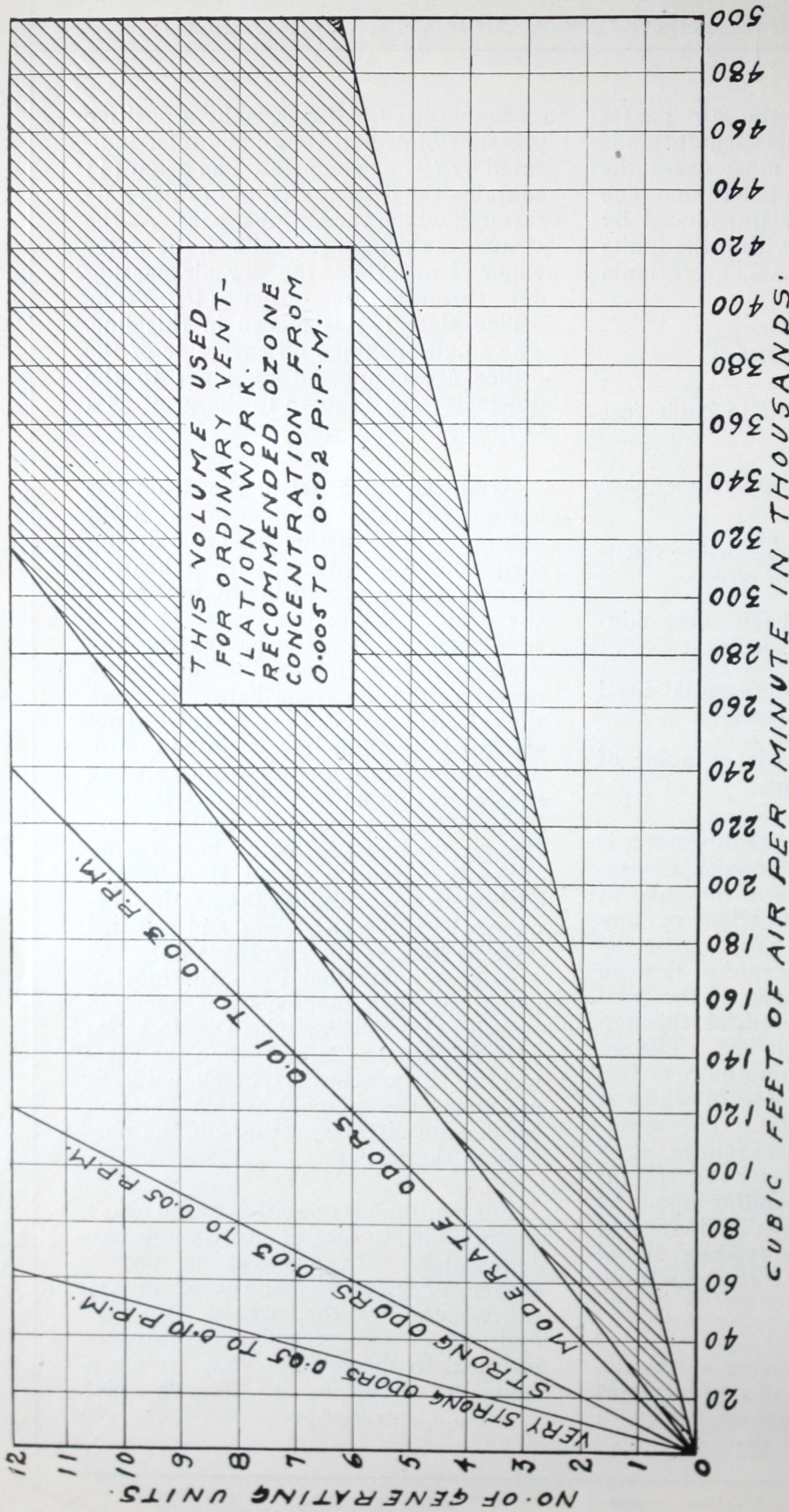
In the schematic drawing of the dehydrator, the direction of movement of the air is indicated by arrows. Air (with

any humidity) is delivered by a positive pressure blower through the inlet indicated by (9) on the print. The drum (1) contains the drying medium (silica gel) through which the air must pass. As the air passes through the gel bed, the water vapor is absorbed, the dry air passing out through the outlet (10). The orifice plate (7) is placed in this line. The small openings on each side of the orifice are connected by pipes to the flowmeter (8) (shown in the print as a U tube.)

After the silica gel in the drum has become saturated, it must be dried out before it can be further used as a drying medium. For this purpose a heating element (2) is placed in the bottom of the drum. While the heater is on, a small amount of air is passed through the dehydrator to expedite the drying process. This air is discharged through the electric valve (5); a valve (not shown) in the pipe line, is closed to prohibit the warm moist air from entering the generating units. The electric valve is normally closed and is shunted across the supply line (3) to the heater unit. When the circuit is closed, allowing the current to flow through the heating element, the valve (5) opens and remains open as long as the current is on. The drying is controlled by a thermostat, which in turn, controls the mercoid switch (4). This switch (4) is in series with the heater (2) and when the thermostat (6) reaches its break point, it motivates the mercoid switch (4) and breaks the circuit, cutting off the current to the heater.

For continuous operation of the ozone machine, it is necessary to employ two dehydrators. In any case a higher degree of efficiency and economy is experienced by the use of two dehydrators. The second dehydrator is identical to the one shown. They are connected at (9) and at (10) with a tee.

(Continued on page 30)



SPECIFICATIONS FOR TYPE EV OZONE GENERATORS

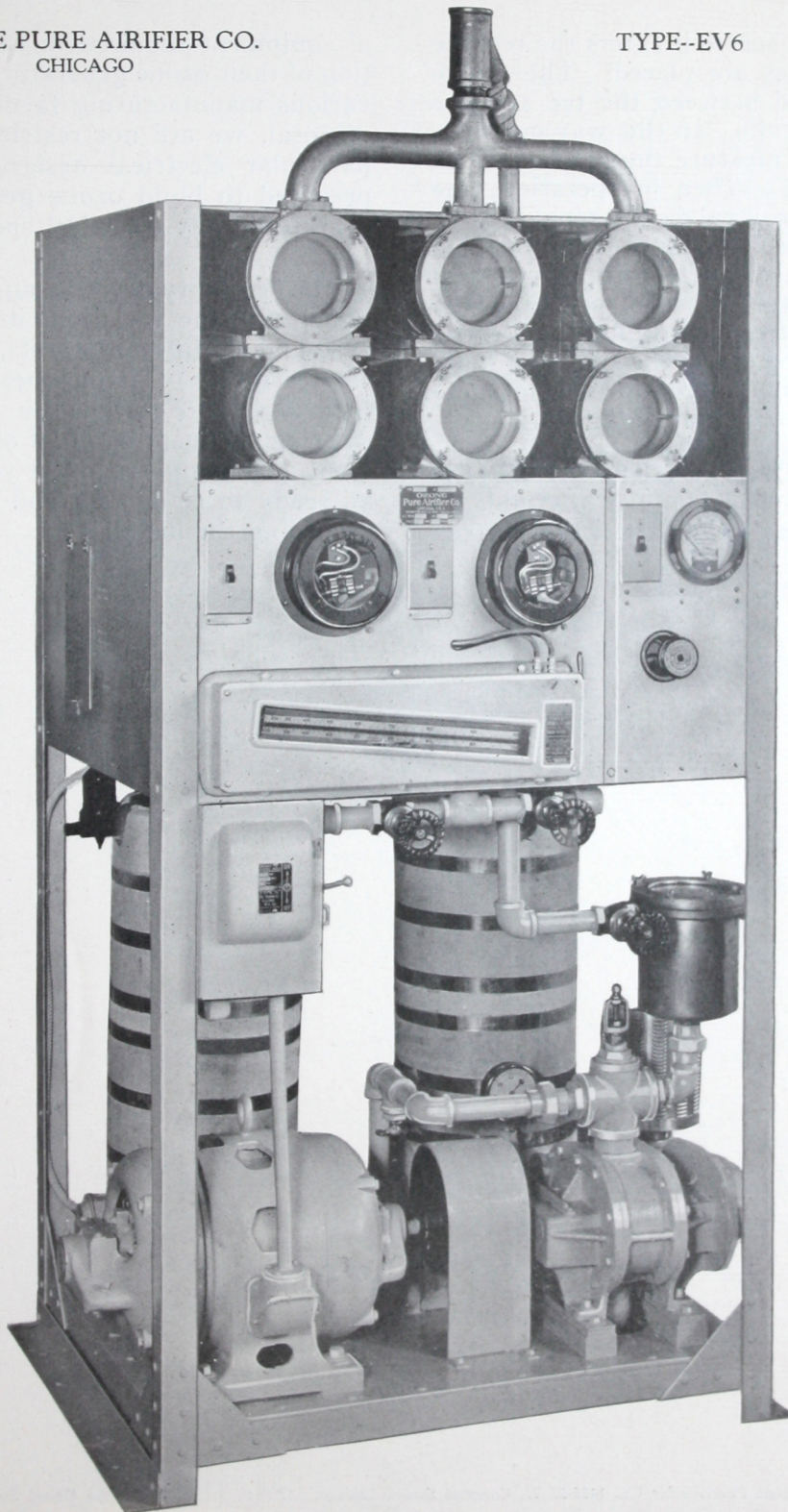
NO. OF UNITS	TOTAL WATTS		DIMENSIONS			APPROX. WEIGHT
	A. C.	D. C.	HEIGHT	WIDTH	DEPTH	
12	2600	2825	84 IN.	37 IN.	31 IN.	1400 LB.
11	2500	2725	84 IN.	37 IN.	31 IN.	1375 LB.
10	2400	2625	76 IN.	37 IN.	31 IN.	1350 LB.
9	2300	2480	84 IN.	37 IN.	31 IN.	1300 LB.
8	2200	2380	76 IN.	37 IN.	31 IN.	1250 LB.
7	2100	2280	76 IN.	37 IN.	31 IN.	1225 LB.
6	2000	2120	76 IN.	37 IN.	31 IN.	1200 LB.
5	2000	2120	68 IN.	37 IN.	31 IN.	1125 LB.
4	1900	2020	68 OR 76 IN.	37 IN.	31 IN.	1100 LB.
3	1900	1990	68 IN.	37 IN.	31 IN.	1000 LB.
2	1500	1550	68 OR 54 IN.	37 IN.	31 IN.	900 LB.
1	1500	1550	54 IN.	37 IN.	31 IN.	875 LB.

THE ABOVE TABLE AND CHART APPLY TO 60 CYCLE CURRENT ONLY

OZONE PURE AIRIFIER COMPANY, CHICAGO

OZONE PURE AIRIFIER CO.
CHICAGO

TYPE--EV6



OZONE PURE AIRIFIER COMPANY, CHICAGO

In pipe (10) before it enters the tee, the control valves are placed. The orifice (7) is placed between the tee and the generating units. In this way one meter serves to measure the air from both dehydrators. When in operation, one of the control valves in pipe (10) is closed. A back pressure is built up behind this valve and no air passes thru the dehydrator. When reactivating, the valve is always closed, but the electric exhaust valve is open and the small amount of air required for drying is exhausted through this valve.

The **OZONE PURE AIRIFIER COMPANY** has found it advisable to manufacture a large part of the electric-

al equipment required in the construction of their ozone generator. With the various manufacturing facilities at our disposal, we are not restricted to any particular electrical design. We are prepared to build ozone generators to operate on any electrical specifications.

The flexibility of this equipment, combined with the variations in conditions as found in different plants, eliminates the feasibility of listing these machines for any definite installation. When considering the installation of ozone equipment, our engineers are at your disposal, ready to co-operate and advise you regarding the installation.



